Summary

This *Puget Sound Update* is the eighth report of the Puget Sound Ambient Monitoring Program (PSAMP) since the program was initiated in 1988 by the State of Washington. The program encompasses the greater Puget Sound region with a broad, interdisciplinary approach.

The *Puget Sound Update* is a technical document that integrates results from all of the PSAMP components and serves as an overall program report issued every two years. The goal of the *Puget Sound Update* is to provide information that can help readers evaluate current efforts to protect and restore Puget Sound's water quality and biological resources and to point out water quality and resource management issues that might require attention now and into the future.

PSAMP uses the *Puget Sound Update* to report on its own results but also to summarize the related work of other researchers in Puget Sound. This report is organized around five monitoring topics that relate to human activities and management programs. Highlights from the chapters dedicated to each of the topics are given below.

Physical Environment

- The region experienced the second worst drought on record in late 2000 and early 2001.
- La Niña conditions were interspersed with neutral conditions with respect to the El Niño—Southern Oscillation (ENSO) over the Pacific Ocean. Based on previous return intervals and ocean conditions in early 2002, scientists anticipate that El Niño conditions may emerge in 2002 and 2003.
- The Washington State Department of Ecology developed a new water quality index (WQI) for rivers and streams designed to measure general watershed conditions. The index shows generally good conditions throughout the basin with fair conditions in south Sound and the lower Stillaguamish and poor conditions at three stations in Skagit County.
- Department of Ecology scientists have developed a ranking of marine water quality concern based on five variables. In this ranking, Budd Inlet, south Hood Canal and Penn Cove showed the poorest water quality but for differing reasons.
- Scientists with the Washington State Department of Natural Resources have determined that 33 percent of Puget Sound shorelines have been modified with bulkheads and half of this amount is associated with single-family residences.

Pathogens and Nutrients

Pathogens

- A new water quality index (WQI) was developed by the Department of Ecology for detecting chronic problems with freshwater fecal coliform bacteria. The fecal WQI showed the lowest level of concern at most ambient freshwater stations within the Puget Sound basin for wateryear 2000 (24 of 33). No ambient

monitoring stations were placed in the highest concern category (the remaining stations were in the moderate concern category).

- Trend analyses at 20 of the Department of Ecology's freshwater stations for 1991-2000 showed seven stations had decreasing fecal contamination, one station at Cedar Run in Renton had an increasing contamination and the remainder had no discernable trends.
- The Washington State Department of Health evaluated fecal pollution in 89 shellfish harvest areas for the period from March 2000 through March 2001. According to its Fecal Pollution Index, 29 areas had significant impact from fecal pollution. The following areas ranked highest in fecal impact: South Skagit Bay, Drayton Harbor, Chico Bay (Dyes Inlet) and Portage Bay. Sixty other harvest areas had minimal pollution.
- The state Department of Health analyzed five-year trends at 302 monitoring stations in Puget Sound that had sufficient data records and evidence of pollution. Fecal pollution increased significantly at 40 percent of the stations. Pollution decreased at a third of the sites and remained unchanged at 27 percent of stations.
- Results from 15 core marine water stations in Puget Sound by the Department of Ecology in 2000 showed the lowest occurrence of high fecal coliform counts since 1994.
- The highest marine fecal coliform counts observed by the Department of Ecology at ambient monitoring stations in 2000 were seen in Commencement, Elliott and Oakland bays. Oakland Bay, however, had only moderate fecal impact in statistics calculated by the state Department of Health using data from commercial shellfish growing areas.
- Several years of analysis of water samples from King County beaches have shown several stations that
  - Consistently have fecal coliform levels that exceed standards: Tramp Harbor, inner Elliott Bay, Fauntleroy Cove, Golden Gardens, Lake Washington Ship Canal, Piper's Creek
  - Consistently have low fecal coliform levels: Seacrest Park, Duwamish Head, north side of Alki Point, Fay Bainbridge State Park.
  - Have highly variable results from year to year: Richmond Beach, Seahurst Park, southern West Point.

Nutrients

- The Department of Ecology's WQI for total nitrogen indicated that the majority of ambient freshwater sampling stations (20 of 33 stations) were in the lowest concern category in water year 2000. The remaining stations were split between moderate concern (7) and highest concern (6). The highest concern stations were in the lower Skagit valley and on the Deschutes River.
- A trend analysis of 1991-2000 data at the Department of Ecology's freshwater monitoring stations indicated decreasing trends or no trends for nitrogen throughout the Puget Sound basin. Slight increasing trends for phosphorus were identified at a number of stations.

- The Department of Ecology scientists identified three areas as having exceptional sensitivity to eutrophication due to a combination of low dissolved oxygen (DO), low dissolved inorganic nitrogen (DIN), and strong, persistent stratification in a 1994-2000 dataset. These areas are Budd Inlet, south Hood Canal and Penn Cove.

Toxics

Sediment

- Comparing surface sediment samples collected in 2000 to results from 1989-1996 at 10 long-term Puget Sound sites showed:
  - Decreases in metal concentrations, particularly mercury and copper.
  - Increases in concentrations of polycyclic aromatic hydrocarbons (PAHs).
  - Substantial increase in benzoic acid at all sites.
  - Particularly high PAH concentrations at the Thea Foss Waterway (Commencement Bay) relative to the other sites.
  - Particularly high metal concentrations—including copper, lead, mercury, silver and zinc—at Sinclair Inlet relative to the other sites.
- Analysis of sediment samples from 300 randomized sites collected in 1997-1999 in Puget Sound showed:
  - The majority of observed sediment contamination was located in urban waters including Bellingham Bay, around March Point, Sinclair Inlet, Everett Harbor, Elliott Bay and Commencement Bay.
  - Greatest toxicity in Everett Harbor, Elliott Bay, Commencement Bay and the Port of Olympia based on a series of four toxicity tests designed to gauge impacts on biota.
  - Greatest percent area of degraded sediments in central Puget Sound, followed by Whidbey Basin and south Puget Sound and Hood Canal regions, based on the weight of evidence developed through a triad of sediment quality information.
  - A portion of each study region, including the majority of Hood Canal, showed no signs of sediment degradation.

Shellfish

- Dungeness crab in Puget Sound accumulate PAHs, with the greatest exposure occurring in crab in urban areas, suggesting that they are suitable as indicator species to quantify PAH exposure in marine biota.
- Analysis of butter clams from six sites in central Puget Sound showed metal concentrations below U.S. Food and Drug Administration (FDA) standards and no detectable organic compounds except benzoic acid, which was prevalent in all samples.

Acronyms

Acronyms are frequently used in this report, especially for compounds such as polychlorinated biphenyls (PCBs) or polycyclic aromatic hydrocarbons (PAHs). A list of acronyms used can be found in the Resources chapter at the end of the report.

Fish

- Concentrations of polychlorinated biphenyls (PCBs) in Pacific herring were higher in fish from central and southern Puget Sound relative to fish from the northern Sound and the Strait of Georgia. These PCB concentrations were generally below values suggested by the National Marine Fisheries Service (NMFS) as thresholds for possible adverse effects in salmonids, although there is a potential for adverse effects in herring stocks in central Puget Sound.
- At long-term sampling stations, English sole in two urban bays (Elliott and Commencement) were observed to have significantly higher risk of liver disease than the intermediate risk measured at Sinclair Inlet and Port Gardner and the lower risk observed in the Strait of Georgia and Hood Canal.
- Monitoring of English sole, rock sole and starry flounder at a site where highly contaminated sediment was capped with clean sediment, showed reduced risk of liver disease associated with reduced exposure to PAHs.

Birds and Mammals

- A study of PCB contaminants in orcas based on samples from 1993-1996 showed very high levels of contamination with clear relationships to food source. Transient orcas that feed from higher trophic levels (marine mammals) were the most highly contaminated of the whales studied. Southern residents were four to six times more contaminated than northern residents, presumably because their food source comes from more contaminated areas of Puget Sound and the Strait of Georgia.
- A study of contaminants in Hood Canal bald eagles concluded that while the population was growing, PCBs were negatively affecting the eagles and causing lower productivity rates relative to populations elsewhere in Washington State.

Human Health

- The state Department of Health reclassified four commercial shellfish growing areas in Puget Sound in 1999, five areas in 2000 and six in 2001. A total of 1,580 acres were upgraded and 2,069 acres were downgraded over these three years.
- The number of confirmed cases of human *Vibrio parahaemalyticus* infection continued the declining trend with each consecutive year since a major outbreak occurred in 1997. There were six cases in 2001 compared to 66 in 1997.
- The state Department of Health observed the greatest concentration of Paralytic Shellfish Poisoning (PSP) toxin in shellfish along the Strait of Juan de Fuca and scattered sites in the Main Basin and south Puget Sound. Areas free of PSP in 2000 included Hood Canal south of Lofall, south Puget Sound west of Anderson Island, Saratoga Passage, and Westcott Bay on San Juan Island.

Biological Resources

Vegetation, Phytoplankton and Macro-Invertebrates

- A statewide inventory of the shoreline called the ShoreZone Inventory was completed in 2000. It characterizes shoreline geomorphology, vegetation, and anthropogenic development along the 3,000 miles of saltwater shoreline in Washington State.
- Eelgrass beds were sampled at 67 sites throughout Puget Sound as part of a new Submerged Vegetation Monitoring Program. This study provides the first estimate of the amount of eelgrass in Puget Sound, and other information on eelgrass bed characteristics. It also serves as a baseline for a long-term monitoring program.
- Kelp canopy area in the Strait of Juan de Fuca increased in both 1999 and 2000 following a strong decrease in 1997 associated with the most recent El Niño episode. In spite of high yearly variability, no long-term trend is apparent in kelp area between 1989 and 2000, suggesting that the population is stable over this time period.
- Phytoplankton blooms in central basin of Puget Sound in 1999 and 2000 were not as consistent as previous years in terms of spatial extent and timing.
- Species diversity in intertidal macro-invertebrates is three times higher in northern Puget Sound relative to the southern Sound with a smooth gradient in between.

Fish

- The Washington State Department of Fish and Wildlife found in their 2000 trawl survey of groundfish in the eastern Strait of Juan de Fuca that most populations were less abundant than previously observed. Some numerically depressed species showed no population growth in response to the recent reduction of fisheries pressure.
- The total amount of spawning herring increased modestly in Puget Sound in 2000 and 2001 although some stocks, particularly the Cherry Point stock, have shown tremendous declines and the reasons for this decline remain unknown.
- Isotopic and genetic studies of Puget Sound herring stocks, including the Cherry Point stock, were not conclusive but did not provide strong evidence in support of treating individual stocks as distinct units under the Endangered Species Act (ESA).
- The state Department of Fish and Wildlife observed an increase in marine survival of juvenile coho and other salmon in the Strait of Georgia in 2000. Other data suggest that this increase is associated with shifts in the food web and a decrease in predation on these species.

Birds

- Baseline data on the pigeon guillemot population, collected in 1999-2000 as part of a new study, showed highest concentrations in the northern and southern areas with fewer numbers in central Puget Sound.

- A new trend analysis of populations of wintering nearshore waterbirds in Puget Sound showed significant decrease in most species studied (grebes, cormorants, loons, pigeon guillemot, marbled murrelets, scoters, scaup, long-tailed ducks and brant), but an increase in harlequin ducks and stable numbers in other species.
- The bald eagle population in Hood Canal is increasing but still trails behind other populations in productivity.

Marine Mammals

- The sharp decline in the southern resident orca whale population continued in 2000 and 2001. This Puget Sound population has declined from a recent maximum of 97 in 1996 to 78 in 2001. High contaminant levels, including PCBs, are a possible factor because they are greater than levels that have been shown to have a negative impact on other marine species. Declining food sources and artificial underwater sounds are other possible negative factors.
- In 2001, a consortium submitted a petition to NMFS to list the southern resident population of orcas, which reside for most of the year in Puget Sound/Georgia Basin, as threatened or endangered under ESA. NMFS completed a biological review and determined that protection under ESA is not warranted because of limitations on how the Act can be applied, not based on the prognosis for the southern resident population.
- The state Department of Fish and Wildlife released a new trend analysis of the harbor seal population in Washington State (1978-1999) that shows an overall threefold increase since enforcement began of the Marine Mammal Protection Act in 1978. The greatest growth has been in the San Juan Islands and the Strait of Juan de Fuca. Model analysis suggests the population is near the current carrying capacity of the inland marine ecosystem in Washington.

Exotic Species

- The Department of Natural Resources conducted a seven-day expedition in 2000 to survey exotic organisms in selected marine areas and documented a total of 40 exotic species. Fewer exotic species were found in Elliott Bay and the Totten/Eld Inlet region (15 species each) compared to Willapa Bay on the outer coast (34 species).
- Coordinated efforts to control the spread of exotic *Spartina*, an invasive aquatic grass, has led to a reduction in the size of the Puget Sound infestation as a whole and the elimination in some areas.